



SAN FRANCISCO MARITIME NATIONAL PARK ASSOCIATION

Hyde Street Pier Science and Living History Programs

This document summarizes how the education programs offered by the San Francisco Maritime National Park Association address CA content-area standards.

The education programs at Hyde Street Pier provide a unique opportunity to bring the many strands of the content standards together in engaging, hands-on experiences. With the help of our crew of professional experiential education instructors, the students are persuaded to imagine the colorful world of the famous Barbary Coast waterfront in the mid-19th to early 20th century. As students are transported to the hard but adventurous life of a sailor, gold prospector, or merchant among the historic ships at San Francisco Maritime National Historic Park, they learn about the challenges posed by life in a different era. The programs integrate social studies, math, science, language arts, and visual and performing arts. Whether it's the physics of how a block-and-tackle works or the music and poetry of sea chanteys, the core themes of the content standards are presented in a lively and imaginative way.

Additional Classroom Activities

The educators on Hyde Street Pier work with teachers to make each group's experience the best it can be. This can include providing practice materials related to the AOS activities that can be used in-class to prepare for the students' eventual visit to the Pier. It can also include a possible early visit and instruction from an AOS educator. For suggested pre and post-visit lesson plans and activities, visit our [website](#). The Hyde Street Pier education programs, in conjunction with in-class lessons and activities, form a complete system addressing CA content standards.

Life on the Barbary Coast Day Program (LIFE)

Just like the Age of Sail Overnight, this shortened, four-hour program puts your students in 1906 as the new crew of *Balclutha*. They have volunteered to help the captain prepare for the evening cast-off and must learn to run the ship as sailors from the period. Performing many of the same activities as the overnight, students are encouraged to develop teamwork and active listening skills to tackle the challenges of life at sea, all under the watchful eyes of the ship's "officers." Since students on the LIFE program experience many of the same activities as the Age of Sail program described below, many of the above descriptions fit this program as well, so the LIFE program accomplishes many of the same standards with some exceptions due to this program's shorter duration.

Summary of 4th through 8th Grade Content Standards for LIFE

Standards Directly Addressed

Standard	Standard Language
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
ESS3.B	Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.
5-PS2-1	Understanding the gravitational forces of Earth acting on an object near Earth's surface pulls that object toward the planet's center.
PS2.B	Defining the gravitational forces exerted by objects in the solar system and how these forces impact each other.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved

	designs.
ETS1.C	Optimizing the Design Solution.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
MS-ESS1-1	Utilizing models of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Utilizing models of the larger celestial bodies to describe the role of gravity in the motions within galaxies and the solar system.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
ESS1.A	Define the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
MS-ESS2-4	Modeling patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth's systems.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
ETS1.C	Optimizing the Design Solution.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object,

	tool, or process such that an optimal design can be achieved.
4.OA	Operations and Algebraic Thinking : Use the four operations with whole numbers to solve problems.
4.OA.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
4.MD.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
4.NBT	Number and Operation in Base Ten.
4.NF	Number and Operations – Fractions.
4.MD.5.a-b	Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
6.EE	Write and evaluate numerical expressions involving whole-number exponents.
6.EE.2	Write, read, and evaluate expressions in which letters stand for numbers.
6.EE.6	Using variables to represent numbers when solving real world problems.
6.EE.9	Using variables to represent two quantities in a real-world problem that change in relationship to one another.
7.NS	Applying and extending previous understandings of operations with fractions.
7.NS.3	Using understandings of operations with fractions for solving “real-world mathematical problems involving the four operations with rational numbers.
HSS4.4	Explaining how California became an agricultural and industrial power, tracing the transformation of the California economy and its political and cultural development.
HSS5.2	Tracing the routes of early explorers and describe the early explorations of the Americas.
HSS5.8	Tracing the colonization, immigration, and settlement patterns of the American people from 1789 to the mid-1800s, with emphasis on the role of economic incentives.

HSS7.11	Analyzing political and economic change in the sixteenth, seventeenth, and eighteenth centuries.
HSS8.8	Analyzing the divergent paths of the American people in the West from 1800 to the mid-1800s and the challenges they faced.
HSS8.12	Analyzing the transformation of the American economy and the changing social and political conditions in the United States in response to the Industrial Revolution.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.

Age of Sail

It is 1906, just days after a devastating earthquake and fire destroyed most of San Francisco. Your students have been recruited to be the new crew of *Balclutha*, whose mission it is to sail to Oregon to bring lumber back to the ruined city so that rebuilding can begin.

During this program's 18-hour duration, your students spend the night on an authentic 19th century sailing ship and live the lives of sailors. The students are divided into groups. Each smaller crew has its own responsibility and job. All of these jobs were historically essential for the ship to function safely. Each individual crew member must learn to work together as a team, and all the crews must cooperate to run the ship. The students are guided by Age of Sail instructors, who play the roles of the ship's four officers. These roles are based on years of research on sailor archetypes from the period, so they are historically accurate, but they are also designed to fit the learning needs of the students.

The historical immersion aspect of this program is its most important characteristic. For one afternoon, evening, and morning, the students live the life of a sailor aboard a real merchant sailing ship. They participate in challenging tasks such as knot tying, swabbing decks, rigging and operating a bosun's chair, lowering and raising dories, and raising sail. The only way students can accomplish the tasks given to them is through communication and cooperation. They must use critical thinking, active listening, problem solving, teamwork, and leadership.

Meeting and Supporting the Standards

Grades 4 and 5: Age of Sail

The student activities in the Age of Sail (AOS) program are especially compatible with 4th and 5th grade California content standards for the STE fields (Earth Systems, Space Systems, and Engineering Design). In addition, students learn and apply skills called for in the Mathematics and English language arts standards.

- **Earth Systems/Plate Tectonics:** In 4th grade, students are expected to understand processes that shape the earth, especially in relation to plate tectonics and large-scale system interactions (ESS2.B).
- **Effects of Natural Hazards on Humans:** They must also “generate and compare solutions to reduce the impacts of natural Earth processes on humans” (4-ESS3-2). This is especially

important when discussing natural hazards such as earthquakes (ESS3.B). Such natural hazards are the result of natural processes. Students must understand that humans cannot eliminate these hazards, but can take steps to reduce their impacts.

The very setting of the AOS program – just a few days after the devastating 1906 San Francisco earthquake – is a lesson that supports students’ understandings of concepts embedded in all of these standards. Since their mission as sailors on the *Balclutha* revolves around the devastation, the students learn first-hand the impact natural hazards such as earthquakes can have on human communities. They learn of the variety of steps taken to reduce the damage and fallout from this disaster, including prevention of future catastrophe. Further, as sailors onboard *Balclutha*, the students learn about the impact of dangerous weather systems on a ship at sea, including the steps sailors could take in order to increase the probability of survival during these storms.

In Class: Maps, Topography, Settlement Patterns

In the classroom, the content standards of the AOS program as outlined above can be further developed through additional lessons and discussion. Through use of maps describing Earth’s features (4-ESS2-2), the 1906 San Francisco earthquake and storms at sea can be used as examples of how large-scale Earth system interactions occur in patterns (ESS2.B). When looking at maps of the earthquake specifically and the comparative destruction it had across the San Francisco Bay area, students can see clearly how different types of land were impacted in different ways. In the city, for example, the parts that were built on filled-in land were hit much harder by the earthquake itself than the parts that were built on natural land that was rocky and mountainous.

- **Space Systems:** In 5th grade, students must learn about space systems, especially how spatial bodies like the earth, sun, and moon interact with each other. This includes understanding that the gravitational force exerted by Earth on objects is directed down toward the planet’s center (5-PS2-1, PS2.B). They must also understand that all objects in the solar system have similar gravitational pulls and therefore have impacts on each other. Specifically, the earth rotates around the sun, the moon rotates around the earth, and these rotations and gravitational interactions cause observable patterns (ESS1.B).

In the Age of Sail program the students learn to row a longboat in the aquatic park near Hyde Street Pier. For safety, this longboat is attached to the dock via a tether line, so the students row the longboat

out to the end of the tether and back. An important part of this activity is learning how the tides work. Students learn that the tides are created by the forces of the moon and the earth interacting with each other. These tides create currents in the Bay that can make the row more difficult or can make the row easier, depending on which direction the current is going at the time. In this way, the students not only learn about the gravitational forces exerted by the Earth and Moon, they also experience the strength of these forces and the patterns that they create by struggling to row against them.

In Class: Using Graphical Displays to Compare

In the classroom, these experiences can be enhanced through graphical displays (5-ESS1-2) and detailed discussion about the Sun's impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth (5-ESS1-1, ESS1.A).

- **Engineering:** Sailing ships like *Balclutha* were engineering masterpieces of their day, making Engineering Design one of the STEM fields that is most compatible with the AOS program. To meet 4th and 5th grade engineering standards, students must “define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost” (3-5-ETS1-1, ETS1.A). They must also work with peers at each stage of their design, because working together and sharing ideas “can lead to improved designs” (3-5-ETS1-2, ETS1.B). And finally, students must test aspects of their engineering model and determine how it can be improved (3-5-ETS1-3).

Throughout the AOS program, the students are given various tasks to accomplish together as a team. Each of these tasks has specific restraints on materials and time. The students must work together through multiple possible solutions to the problem given to them in order to accomplish their assigned tasks. From swabbing decks, to setting sails, to measuring the depth of the Bay using an old fashioned lead line, every activity the students do during the AOS program helps to meet the Engineering standards. The best example can be found with the bosun's chair activity. The bosun's chair is a pulley system used to raise sailors aloft with the purpose of making repairs to ship rigging. Students are tasked with constructing this system from base materials: chair, harness, lines, blocks, and belaying pins. As a team, students must identify the necessary materials themselves and then, step by step, use these materials to create the bosun chair system. At each step, the students must reach a specific solution using restricted timeframes and materials. Once the entire system is constructed, they must then learn

to use the system properly and raise people up in it. As with most activities on the pier, this activity fits especially well with “Crosscutting Concepts,” as the students effectively learn the influence that science, engineering, and technology have had on society through hands-on problem solving experience.

Summary of 4th and 5th Grade Content Standards for Age of Sail

AOS 4th Grade Standards Directly Addressed

Standard	Standard Language
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
ESS3.B	Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
ETS1.C	Optimizing the Design Solution.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
4.OA	Operations and Algebraic Thinking : Use the four operations with whole numbers to solve problems.
4.OA.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
4.MD	Measurement and Data: Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

4.MD.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
4.NBT	Number and Operation in Base Ten.
4.NF	Number and Operations – Fractions.
4.MD.5.a-b	Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.
HSS4.4	Explaining how California became an agricultural and industrial power, tracing the transformation of the California economy and its political and cultural development.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.
W4-8.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
W4-8.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W4-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AOS 4th Grade Standards Supported

Standard	Standard Language
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.
ESS2.B	Understanding processes that shape the earth, especially in relation to plate tectonics and large-scale system interactions.
4.G	Identifying lines and angles, and classify shapes by properties of their lines and angles.
4.MD	Solving problems involving measurement and conversion of measurements.
4.MD.5-7	Understanding concepts of angle and measure angles in geometric measurements.
4.G.1-3	Identifying lines and angles, and classify shapes by properties of their lines and angles.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing

	and contrasting one author’s presentation with that of another.
RF4-8.1-10	Develop students’ understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

AOS 5th Grade Standards Directly Addressed

Standard	Standard Language
5-PS2-1	Understanding the gravitational forces of Earth acting on an object near Earth’s surface pulls that object toward the planet’s center.
PS2.B	Defining the gravitational forces exerted by objects in the solar system and how these forces impact each other.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
ETS1.C	Optimizing the Design Solution.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
HSS5.2	Tracing the routes of early explorers and describe the early explorations of the Americas.
HSS5.8	Tracing the colonization, immigration, and settlement patterns of the

	American people from 1789 to the mid-1800s, with emphasis on the role of economic incentives.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.
W4-8.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
W4-8.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W4-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AOS 5th Grade Standards Supported

Standard	Standard Language
5-ESS1-2	Developing a model using an example to describe how different “spheres” of Earth interact.
5-ESS1-1	Supporting that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.
ESS1.A	Define the Sun’s impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
5.NBT.5	Multiplying Number and Operation in Base Ten.
5.NF	Number and Operations – Fractions.
5.NF.6	Multiplying Fractions using Real-world problems.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author’s presentation with that of another.
RF4-8.1-10	Develop students’ understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.

Meeting and Supporting the Standards

Middle School (grades 6-8): Age of Sail

The student activities in the Age of Sail (AOS) program are especially compatible with middle school (6th - 8th grade) California content standards for the STE fields of Physical Science, Earth and Space Systems, and Engineering Design. In addition, students learn and apply skills called for in the Mathematics and English language arts standards.

- **Space and Earth Systems:** In order to prove competency in Space and Earth Systems, middle school students must understand models of the “Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons” (MS-ESS1-1).
- **The Role of Gravity:** Concurrently, they must understand “the role of gravity in the motions within galaxies and the solar system” (MS-ESS1-2, ESS1.B, ESS1.A). These patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth’s systems (MS-ESS2-4).

In the AOS program the students learn to row a longboat in the aquatic park near Hyde Street Pier. For safety, this longboat is attached to the dock via a tether line, so the students row the longboat out to the end of the tether and back. An important part of this activity is learning how the tides work. Students learn that the tides are created by the forces of the moon and the earth interacting with each other. These tides create currents in the Bay that can make the row more difficult or can make the row easier, depending on which direction the current is going at the time. In this way, the students not only learn about the gravitational forces exerted by the earth and moon, they also experience the strength of these forces and the patterns that they create by struggling to row against them.

- **Weather and Climate:** Understanding tides and currents was essential to being a successful sailor. Indeed, it could mean the difference between life and death. Equally, if not more important, was having an understanding of weather and climate. In middle school, students must understand weather and climate through the development and use of models describing

the relationships between earth heating, rotation, atmospheric patterns, and oceanic circulation (MS-ESS2-6). These interactions are further influenced by living things and vary depending on latitude, altitude, and geography (ESS2.D). Students must also be able to discuss the evidence for the many “factors that have caused the rise in global temperatures over the past century” (MS-ESS3-5), especially human activity (ESS3.D, MS-ESS3-4).

In the AOS program, the students work on the ship as sailors whose livelihood depended on knowledge of weather and climate. They see and feel firsthand the “complex interactions of air masses” that affect weather conditions (MS-ESS2-5). They experience the powerful role that water, ocean temperatures, and currents have in determining local weather patterns (ESS2.C). Often, they see the changes for themselves as the fog rolls through the Golden Gate, the rains come and go, or the winds change direction and strength.

- **Engineering:** Sailing ships like *Balclutha* were engineering masterpieces of their day, making Engineering Design one of the STEM fields that is most compatible with the AOS program. To meet middle school engineering standards, students must “define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution,” while considering scientific principles and impacts that might limit possible design solutions (MS-ETS1-1, ETS1.A).
- **Problem Solving:** They must develop possible solutions (ETS1.B) by “using a systematic process to determine how well they meet the criteria and constraints of the problem” (MS-ETS1-2). Their solutions should then be optimized (ETS1.C) through tests and analysis of test data to identify the “best characteristics of each that can be combined into a new solution to better meet the criteria for success” (MS-ETS1-3). Finally, they must “develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved” (MS-ETS1-4).

Throughout the program, the students are given various tasks to accomplish together as a team. Each of these tasks has specific restraints on materials and time. The students must work and brainstorm together through multiple possible solutions to the problem given to them in order to accomplish their assigned tasks. From swabbing decks, to setting sails, to measuring the depth of the Bay using an old fashioned lead line, every activity the students do addresses these Engineering standards.

One of the best examples can be found with the bosun’s chair activity. The bosun’s chair is a pulley system used to raise sailors aloft with the purpose of making repairs to ship rigging. Students are tasked with constructing this system from base materials: chair, harness, lines, blocks, and belaying pins. As a team, students must identify the necessary materials themselves and then, step by step, use these materials to create the bosun chair system. At each step, the students must reach a specific solution using restricted timeframes and materials. Once the entire system is constructed, they must then learn to use the system properly and raise people up in it. As with most activities on the pier, this activity fits especially well with “Crosscutting Concepts,” as the students effectively learn the influence that science, engineering, and technology have had on society through hands-on problem solving experience.

Summary of Middle School Content Standards for Age of Sail

AOS Middle School Standards Directly Addressed

Standard	Standard Language
MS-ESS1-1	Utilizing models of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
MS-ESS1-2	Utilizing models of the larger celestial bodies to describe the role of gravity in the motions within galaxies and the solar system.
ESS1.B	Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.
ESS1.A	Define the Sun’s impact on the earth and its role as one star of countless in the universe. Its brightness and size in comparison with other stars are due to its close proximity to Earth.
MS-ESS2-4	Modeling patterns and forces of gravity, along with the energy of the sun, impact the cycling of water through Earth’s systems.
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
ETS1.A	Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
ETS1.B	Developing Possible Solutions: At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.

MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
ETS1.C	Optimizing the Design Solution.
MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
6.EE	Write and evaluate numerical expressions involving whole-number exponents.
6.EE.2	Write, read, and evaluate expressions in which letters stand for numbers.
6.EE.6	Using variables to represent numbers when solving real world problems.
6.EE.9	Using variables to represent two quantities in a real-world problem that change in relationship to one another.
7.NS	Applying and extending previous understandings of operations with fractions.
7.NS.3	Using understandings of operations with fractions for solving “real-world mathematical problems involving the four operations with rational numbers.
HSS7.11	Analyzing political and economic change in the sixteenth, seventeenth, and eighteenth centuries.
HSS8.8	Analyzing the divergent paths of the American people in the West from 1800 to the mid-1800s and the challenges they faced.
HSS8.12	Analyzing the transformation of the American economy and the changing social and political conditions in the United States in response to the Industrial Revolution.
SL8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
SL4-8.1-6	Accomplishing objectives given through communication and cooperation, through critical thinking, active listening, problem solving, self-respect, teamwork, and leadership.
L4-8.1-6	Demonstrating command of the conventions of standard English grammar and usage when writing or speaking, using knowledge of language and its conventions when writing, speaking, reading, or listening, and determine or clarify the meaning of unknown and multiple-meaning words and phrases.
W4-8.2	Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
W4-8.3	Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
W4-8.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AOS Middle School Standards Supported

Standard	Standard Language
MS-ESS2-5	Collecting data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
ESS2.D	Developing a model determining how weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
ESS3.D	Applying scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4	Constructing an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ESS3-5	Clarifying evidence of the factors that have caused the rise in global temperatures over the past century.
ESS2.C	Describing The Roles of Water in Earth's Surface Processes.
7.G	Drawing, constructing, and describing geometrical figures and describe the relationships between them.
7.G.2	Drawing Geometric shapes with given conditions.
7.G.5	Using facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problems.
RL4-8.1-10	Students gain adequate exposure to a range of texts and tasks. Students read increasingly complex texts through the grades.
RI4-8.1-10	Citing evidence, determining central text ideas and word meaning, analyzing how particular sections fit into overall text, tracing authors specific argument or point-of-view, and comparing and contrasting one author's presentation with that of another.
RF4-8.1-10	Develop students' understanding and working knowledge of concepts of print, the alphabetic principle, and other basic conventions of the English writing system.
W4-8.1-10	Students gain adequate mastery of a range of skills and applications. Each grade, students should demonstrate increasing sophistication in all aspects of language use, from vocabulary and syntax to the development and organization of ideas, and they should address increasingly demanding content and sources.